**Appendix 4 – Soil Sampling Plan**

# Introduction

This soil sampling plan has been prepared as part of the Site Specific Land Application Plan for the North Ranch Lime Stabilization and Recycling Facility. The intent of this plan is to outline the sampling, handling, and testing protocol that Bio Recycling Corp (BIO) or its agent will follow to obtain representative soil samples at the North Ranch site.

The primary goals of soil sampling are: (1) to provide data needed to evaluate the basic chemical properties of site soils to ensure adequate crop productivity while minimizing environmental risk; (2) to evaluate compliance with the WAC 173-308-190 requirements for application of biosolids at an agronomic rate.

# Approach to Soil Sampling and Compliance Monitoring

Compliance with the agronomic rate requirements will be evaluated using the *"post-harvest soil nitrate"* approach. This approach evaluates soil nitrate in the fall after biosolids application to determine if the application rates were appropriate; adjustments are made if over- or under-application is suggested by the soil nitrate results. For guidance on collecting soil samples and evaluating results, BIO will use the most recent version of the following documents:

- Oregon State University Extension Service's document, *Post-harvest Soil Nitrate Testing for Manured Cropping Systems West of the Cascades* (EM 8832-E). This document can be found at: http://extension.oregonstate.edu/catalog/pdf/em/em8832-e.pdf.

- University of Idaho Cooperative Extension Service's document, *Soil Sampling* (Bulletin 704). This document can be found at: http://www.cals.uidaho.edu/edComm//pdf/EXT/EXT0704.pdf..

# Analyses to be Performed

At an absolute minimum, total nitrate-nitrogen will be analyzed each year for each field where biosolids were applied during the year. Other constituents will be analyzed as needed upon recommendation from the lab, Washington State University Cooperative Extension, a soil scientist, or an agronomist or if required by the land owner or Ecology. Additional analyses may include, but are not limited to, phosphorous, potassium, sulfur and other nutrients as well as pH, cation exchange capacity, and electrical conductivity, and organic matter.

The following table describes the methods, basic preservation, and lab requirements for nitrate-nitrogen analysis BIO will use.

| Minimum Required Analyses | | | |
|---|---|---|---|
| **Analyte** | **Methods** | **Basic Preservation** | **Lab Requirements** |
| Nitrate-nitrogen | EPA 353.2<br>or<br>SM 4500-$NO_3$ E, F, or H | Place in iced cooler and maintain at ~4° C until delivered to lab. | Analyze within 28 days of collection.<br>Be accredited by Ecology for the method used under the 'Solids and Chemical Materials' matrix.<br>Report in mg/kg (dry weight basis) |

# Fields (Sampling Units) to be Sampled

All fields that received biosolids during the application season will be sampled. Initially each field designated on the site map will be considered as a separate sampling unit. Thus, initially there will be eight (8) sampling units for the site.

If conditions warrant, the number of sampling units may increase. For example, if the land owner decides to break-up an existing designated field to grow a different crop, the area where the different crop will be grown will be considered as a new sampling unit. In addition, if soil sampling reveals that some areas should be evaluated separately (for example, if a distinctly different soil type is revealed), new sampling units will be designated.

# Number of Subsamples to be Collected and Composite Samples to be Prepared

Based on the current acreage, a minimum of 20 discrete grab samples (subsamples) will be collected from each sampling unit. If new, smaller sampling units are created, if soil augering encounters refusal, or if application 30 days prior to sampling prevents a full field sample pattern, then the number of subsamples collected may be decreased, but at no time will we collect less than 10 subsamples per composite sample.

Three (3) composite samples will be prepared from the subsamples collected for each sample depth increment (0-12", 12-24", 24-36") per sampling unit. Irregardless of refusal conditions, a single surface increment (0-12") composite sample will be prepared for each sampling unit, even if this requires hand-dug pits in place of the soil auger.

The following table shows the acreage, the number of subsamples we will collect, and the number of composite samples we will prepare per sampling unit.

| Minimum Number of Subsamples and Composite Samples Required Per Sampling Unit | | |
|---|---|---|
| **Sampling Unit** | **Number of Subsamples** | **Number of Composite Samples** |
| Field 1 – 30 acres | 25 | 3 |
| Field 2 – 31 acres | 25 | 3 |
| Field 3 – 35 acres | 25 | 3 |
| Field 4H – 67 acres | 30 | 3 |
| Field 4P East – 25 acres | 20 | 3 |
| Field 4P West – 50 acres | 25 | 3 |
| Field 10 – 44 acres | 25 | 3 |
| Field 11 – 33 acres | 25 | 3 |

# Sampling Depth

By order of Ecology, the top 3-foot (0-36") of soil will be sampled. Generally only the top 1-foot (0-12") of soil is sampled. Deeper sampling may occur if recommended by the lab, Washington State University Cooperative Extension, or an agronomist or if required by the land owner or Ecology.

# Sampling Timing

Sampling at the North Ranch site will take place as soon as possible after the fall crop harvest but before 3" of post-September 1st rainfall has occurred; we will include any post-September 1st irrigation water applied in calculating the cumulative rainfall. If possible, we will wait at least 30 days after biosolids application before conducting sampling. However, our priority will be to sample before 3" of post-September 1st rainfall rather than focusing on synchronizing sampling with the harvest timing or the application timing.

Samples must be taken before heavy fall rains move nitrate below the 12-inch depth. Because the timing of fall rainfall is unpredictable, the best strategy is to sample fields before October 1 whenever possible. As a general rule we expect to collect samples around October 1st.

BIO may take later season comparative samples to evaluate subsequent crop uptake. To be informative, comparative samples must be taken before heavy fall rains move nitrate below the 36 inch sample depth. As a general rule we expect to collect comparative samples around October 15th.

# Parameters for Choosing a Lab

We will work with a lab that is familiar with soil sampling and crop needs and capable of properly analyzing soils. For nitrate-nitrogen analyses, we will ensure that the lab is accredited by Ecology for the method they use and that the accreditation is under the 'Solids and Chemical Materials' matrix.

# Sampling and Handling Procedures

The following subsections provide the steps and directions for BIO staff or BIO agents to follow when collecting and handling representative soil samples.

## Soil Sampling Tools

Use proper soil sampling tools. Soil augers are more effective than soil probes when sampling the gravelly Alderwood soils at the North Ranch site. Where depth to auger refusal is less than the full 12" needed to produce a representative sample, you can use a shovel or spade.

## Prior to the Sampling Event

- Contact the lab approximately two weeks prior to the sampling event. Request containers, custody seals, and chain of custody forms. Be specific about the analyses needed, as different analyses may require separate containers. Also be sure to ask if the lab will need more than 1 sample for analysis and the volume of sample they will need.

- Obtain an adequately sized and scaled map of the sampling unit so that the sample transect and locations can be marked. Using the map, roughly plan out the sampling transect.

- Inventory and inspect the sampling equipment needed (see list below). Be sure the soil auger, shovel or spade, screwdriver, plastic buckets, tarp, trowel, and cooler are all clean and in good working order.

### Sampling Equipment Needed

- Personal protective gear such as boots and gloves
- GPS unit (optional)
- Pens, markers
- Field notebook
- Map of sampling unit
- Soil auger capable of extracting a ~~12”~~ 36” soil sample
- Screwdriver or similar tool to help remove soil from the auger
- A ½” to 1” screen
- Three (3) individual 5-gallon plastic buckets: 3 for retaining subsamples, 1 for screening
- Tarp or other work surface for compositing samples
- Trowel or similar tool for mixing
- Sample ~~containers~~ [bags]
- Labels for sample ~~containers~~ [bags]
- Custody seals
- Chain of custody forms
- Cooler and ice for samples

## Collecting Subsamples

### General Guidelines

- Subsamples must be randomly collected from across the entire sampling unit. Follow a meandering, zigzag pattern across the sampling unit.

- Randomly choose a starting point near one end of the sampling unit. Subsequent locations must also be chosen randomly, but be sure to cover the entire sampling unit.

- Avoid collecting subsamples in small, atypical areas such as swales, rocky areas, roads, depressions, and edges. Also avoid collecting subsamples from areas where biosolids have been applied in the past 30 days. (NOTE: Collecting subsamples from such areas may skew the results.)

- A minimum of 10 subsamples must be collected from each sampling unit.

## Specific Collecting Instructions.

- Scrape away any loose crop residue or biosolids present on the soil surface.

- The auger is held vertically and is driven into the ground. It is then rotated while under downward pressure to achieve the desired sample depth.

- If a rock or other object prevents the collection of a full subsample increment, discard any soil in the auger, move to a nearby location, and blind auger (continuous augering without sampling) to the top of the refused 12" increment, and continue sampling from that depth. If the second attempt also results in refusal, soil sampling should proceed to next sample point.

- However, if it is clear that you will complete the sample pattern in that sampling unit with less than 10 subsamples per surface foot composite, you must proceed to replace soil auger sampling with pit sampling to assure meeting this minimum requirement.

- For each full 12" increment, pull the soil auger from the soil. Using the screwdriver or other tool remove all the soil in the auger and place it in the plastic bucket allocated to that increment.

- Move to the next, randomly chosen subsample collection point following a meandering, zigzag pattern and follow the 3 previous steps.

- Repeat until the entire sampling unit has been covered.

## Compositing Subsamples

- Pour the entire contents of the plastic bucket onto a smooth clean surface such as a tarp or a piece of plywood.

- Break up any large clods of soil. Remove large stones, large pieces of wood, and large clumps of vegetative matter after shaking off any attached soil. (NOTE: If desired, each core can be processed through a ½"–1" screen as it is placed into the bucket.)

- Mix the combined sample thoroughly by hand and/or a trowel or a similar tool. (NOTE: This process can be started by moving the bucket around, but it must be finished by working the pile manually.) Be sure to bring material from the bottom of the pile to the top several times so that the mixing is complete.

- Slice the pile into 4 quarters and randomly discard 3 of the quarters. Mix the remaining quarter again, divide it into quarters and randomly discard three. Continue this process until the proper volume of sample as requested by the lab has been obtained; this commonly is around 1 pint of soil, but it may be smaller or larger depending on the analyses to be performed. A single mixing and quartering may be sufficient, depending on the size of the soil auger and number of subsamples taken.

## Handling the Composite Sample

- Place the composite sample into the sample container provided by the lab or recommended by the lab (a zip lock bag is often sufficient).

- Label the sample clearly. Use an identification number that makes sense, as the lab will use the number in its report. For example, *"4PE-A"* could be used to designate *"Field 4P East, Composite #A from 0-12 inches"*. With 8 fields and 3 composites per field (for example *"..A"*, *"..B"*, and *"..C"*), need to plan for 24 sample bags.

- Place a custody seal across the container opening and initial and date as indicated on the seal.

- Place the sample in a cooler with ice and maintain at ~4° C until delivered to the lab for analysis. (NOTE: Samples must be maintained below 10° C to prevent conversion of nitrogenous compounds from one form to another thereby skewing the results.)

## Maintaining a Written Record for Each Sampling Event

- In the field notebook write down the sampling unit designation, the number of subsamples and composite samples obtained, an explanation of the sample identification numbers, the time and date of the sampling event, and the name of the person performing the sampling. Also include any pertinent notes on the sampling event such as the weather conditions or soil descriptions (for example: "wet, dark brown, sandy-loam").

- On the sampling unit map write down the approximate location of each subsample point. Use a line to show the sample transect. Include notes about sampling unit conditions and any factors that influenced subsample locations.

## Completing the Chain of Custody Form

- A chain of custody form must be completed. The chain of custody form is the written documentation of the security of a sample from the time it is collected to the time it is transferred to the lab. Chain of custody procedures must be followed to ensure that lab results can be used to document compliance.

- Complete all items on the chain of custody record form upon completion of a sampling event.

- Place the chain of custody form in a zip lock bag or other dry location and put it into the cooler along with the samples for transport to the lab.

## Delivering Samples to the Lab

- Deliver samples to the lab on the day of or the day after sampling.

- After the lab receives the samples, the lab technician will inspect the samples, note any exceptions to proper handling requirements, and sign-off on the chain of custody form.

- A copy of the chain of custody record will be provided back to the sampler/deliverer and must be placed in the permanent project file.